

THROTTLING CALORIMETER

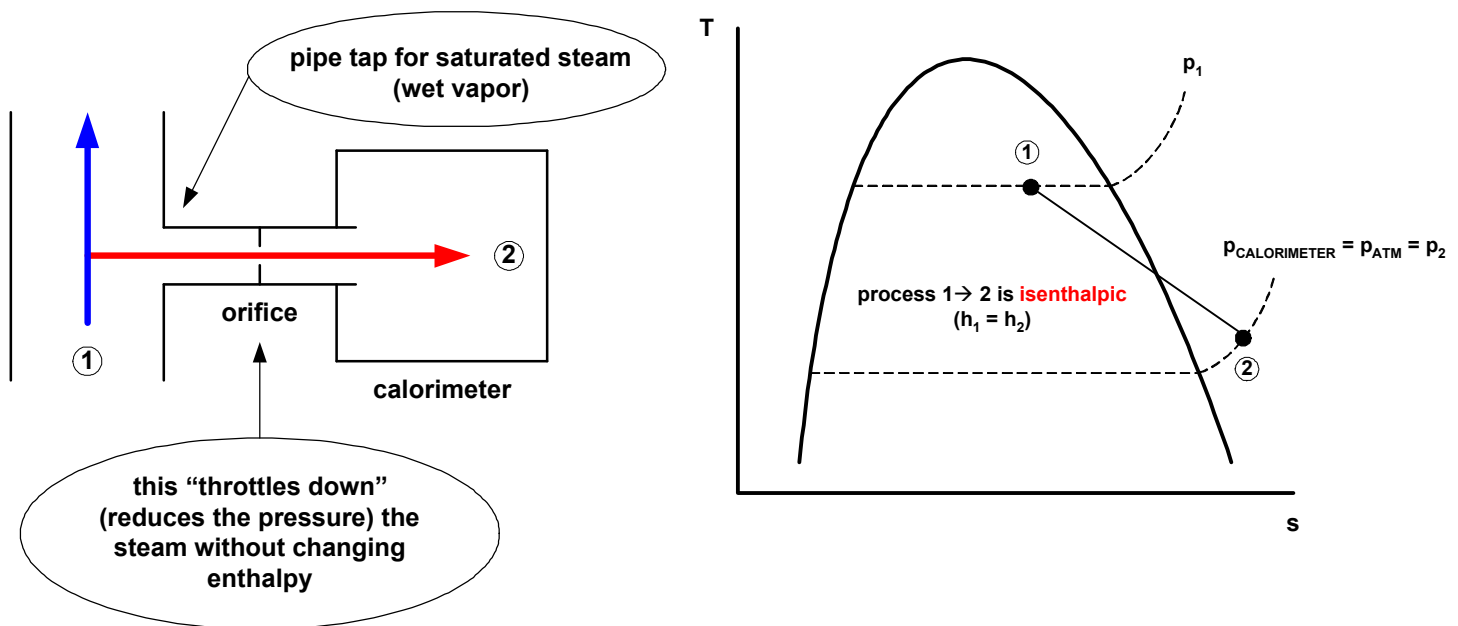
This is a device used to measure steam quality (x) of saturated steam (a.k.a. wet vapor).

The calorimeter is kept at a known pressure (atmospheric pressure). The saturated steam is tapped through a pipe and sent through an orifice to the calorimeter. In the process of “**throttling down**” (decreasing pressure) this high pressure saturated steam to atmospheric pressure, it flashes to superheated vapor (crosses the steam dome). The **throttling is isenthalpic** (enthalpy remains the same at the start and end points of the process, $h_1 = h_2$).

The isenthalpic nature of the throttling process allows us to find not only h_2 (in the calorimeter), but also h_1 (in the saturated steam) because $h_1 = h_2$. Then knowing h_1 , we can find the steam quality (x) at state point 1 by the usual calculation method of:

$$h_1 = h_f + x_1(h_{fg})$$

where h_f and h_{fg} are looked up at p_1 (or T_{sat} at p_1) in the steam tables



The throttling calorimeter is needed because we do not know any properties of the saturated steam at state point 1 other than pressure and temperature (both of which are constant inside the steam dome for an infinite number of h , s , and x values). Without knowing h , s , or x at state point 1, we cannot calculate steam quality (x). The throttling calorimeter allows us to find h_2 and, thus, h_1 .

How do we find h_2 ? By knowing $p_2 = p_{ATM}$, and knowing T_2 (measured with a thermometer), and knowing that state point 2 is superheated vapor, we can look up h_2 in steam table 3 (superheated vapor table).